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THE HAWAIIAN PLANTERS' MONTHLY

PUBLISHED FOR THE

HAWAIIAN SUGAR PLANTERS' ASSOCIATION

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SUGAR PRICES FOR MONTH ENDING MARCH 13, 1908.

		Centrifugals.	Beets.
February	14, 1908..........	3.67¢	9s. 9¾d.
"	21, 1908..........	3.73¢	9s. 9¾d.
"	28, 1908..........	3.885¢	10s. 0¾d.
March	6, 1908..........	3.89¢	10s 3d.
"	13, 1908..........	4.027¢	10s. 6¾d.

Messrs. Willett & Gray in their "Weekly Statistical" of February 20, state as follows:

There has been no further decline in the raw sugar market during the week under review, notwithstanding the general expectation that increased offerings would produce such results. As a matter of fact, the increased offerings were not forthcoming, and all the offerings made were readily absorbed on the basis of 2 5-16c. c. & f., 96° test, or 3.67c. per pound duty paid.

An effort towards the close to obtain an advance of 1-32c. proved unsuccessful and the market remains the same apparently, running along at or near the bottom prices for the season.

The Cuba crop receipts increased to 56,000 tons, with exports 33,000 tons and stock 89,000 tons, with 166 Centrals working. Stock in the United States and Cuba together is now 215,095 tons, against 384,079 tons last year.

Receipts at Four Ports United States were 42,165 tons and meltings 30,00 otons, increasing stock 12,165 tons.

Our detailed weather reports show some rain on the Island, but not enough to interfere with grinding. There are some planters in Cuba who take exceptions to the general crop estimates and we give the views of one such herewith, that both sides may be represented in reports from different parts of the Island. There is no doubt that the Cienfuegos district will produce a large shortage.

Prospects point to continued low prices (now 39c. per 100 pounds below European parity) for a few weeks longer.

Europe continued its small fluctuations from day to day, finally ending at 9s. 9¾d., against 9s. 10½d. at the beginning.

Mr. Licht continues to have nothing to say in his weekly cables to us except that the weather is favorable for field work and the sowings for Germany promise a trifle smaller than last year.

Czarnikow, Macdougal & Co. in their report of February 1, say:

During the greater part of the week the most that could be said of the market was that it held firm at last week's final prices, and that refiners were ready to take additional quantities at the decline then established, although, at same time, they expressed the belief that a further decline was inevitable before prices touched bottom.

Fortunately for the market, offerings of Cubas did not pour forth in the volume that buyers had hoped to see as soon as grinding became general. On the contrary, the stream was so scant that refiners had to stimulate it by a pronounced show of interest, which in the end resulted in the market developing conspicuous strength and recovering the whole of last week's decline. This recovery was more marked because it took place in the face of flat and inactive European markets. It appears evident that planters have already sold practically the whole of their production up to date, and that they are not in the mood to sell much sugar ahead at the prices named by buyers.

The sales at the recovery are estimated to amount to 70,000 bags, and more could be disposed of at same price, 2.38c. c. f., March shipment, but sellers are scarce.

European Beet markets opened flat, and present crop at one time showed a decline of 1½d. from last week's closing prices, but part of this has since been regained. Next crop has been steady and is fractionally higher than last week. Today's f. o. b. quotations: February, 9s. 9¾d.; March, 9s. 9½d.; May, 10s.; August, 10s. 2¼d. Next crop, 9s. 8d.

NOTES.

SEEDLING CANES IN CUBA.—A recent Bulletin of the Secretary of Agriculture of Cuba contains a report on cane seedlings at the Harvard Botanical Garden for 1907. Notwithstanding the season of 1906-1907 was a very severe one, as it brought heavy rains, a cyclone and an unprecedented drought, all of which did great damage to the canes and other plants of the gardens,—some five hundred seedling canes out of seven hundred or more raised in the green house, were saved and planted in the experimental field, from which forty-five stools of the strongest and more promising hybrids were cut and analyzed.

It would be interesting to know definitely whether these hybrids were obtained by hybridization under control so that the parentage of the resulting canes was established beyond question of doubt, or whether they were obtained by what may be called natural hybridization where varieties of cane that arrow at the same time are planted in alternate rows and the resultant seedlings are considered as the result of a cross or of self-fertilization.

The analysis of each of the 45 hybrids raised by the Harvard Station is given in the bulletin and it is interesting to note that in some instances the best results have been obtained from varieties which have also given good results in Hawaii.

The Harvard Station reports that Demerara No. 95 crossed with Cuban varieties has produced excellent results. Mr. Eckert of the Hawaiian Sugar Planters' Experiment Station, puts some seedlings of D. 95 in his 12 richest seedlings class.

Barbados 109 crossed with Cuban canes has also given good results in Cuba. This Barbados cane has not been introduced here.

CUBAN LABOR TROUBLES.—Labor is scarce on some of the sugar plantations and the Agrarian League is urging the expenditure of the money amounting to $1,000,000 appropriated by the Cuban Congress to encourage immigration. The matter will be brought to Governor Magoon's attention when he returns to Cuba.

The immigration from Spain during the last few years has been large,—22,178 in 1907 and 44,672 in 1906,—and most of the immigrants readily found employment. The work on Cuban roads has kept labor busy all over the Island and created a scarcity in the fields.

"FUNGUS MALADIES OF THE SUGAR CANE."—In a recent issue of "Nature" appears the following review of Bulletin Number 5 of the Division of Pathology of the Experiment Station of the Hawaiian Sugar Planters' Association, on "Fungus Maladies of the Sugar Cane," by Dr. N. A. Cobb, formerly Director of the Division and now of the United States Department of Agriculture:

"PLANT DISEASES AND REMEDIES.

"The experiment station of the Hawaiian Sugar Planters' Association has issued as Bulletin No. 5[1] a remarkable publication which not only deals in a very comprehensive and thorough way with the fungus enemies of the sugar-cane, but also

[1] "Fungus Maladies of the Sugar Cane," N. A. Cobb—Honolulu.

contains a series of valuable notes on associated insects and nematodes.

"The volume has bound with it also Bulletin No. 4 of the same station, and by the same author. This bulletin is on some elements of Plant Pathology. In the course of the work mention is made of new blights found in the cane-fields of Hawaii, and of the new and threatening aspects of the blights already known.

"Part I. is introductory, and may be passed over. Part II. deals with the root diseases of sugar-cane. In this connection which covers eighty-five pages, we have a most accurate and interesting description of the strange Ithyphallus fungus, which is one of the causes of root disease. 'Time alone can show,' Mr. Cobb tells us, 'what the relative importance of the Ithyphallus fungus will be among the root diseases of cane.' The serious losses caused by the fungus and its early history are first traced, and then the extraordinary fructifications are detailed and admirably illustrated. Then follows an account of the relations of insects to Ithyphallus. The author tells us that five species of flies, a beetle, and an ant frequent the fresh fructifications, and that some of the flies are so passionately fond of the sticky dark-green spore-mass that they can scarcely be driven away.

"Dispersal of this fungus by their agency, especially in the excreta, is proved, and although the flies are not named generically, they were known to be Scarcophagidae and Muscidae. The work done in this subject is remarkable. It was shown that the spores are also carried in numbers on the feet. The spores from five of the fly tracks on glass were found to be 860,000 per track. Then follow notes on digestive power of flies, notes on defection (the number of spores found in a 'fly speck' was shown to be 22,400,000 in some instances) even the weight of a fly ration is gone into with wonderful exactness.

"The use of lime as a fungicide is pointed out, and methods of cultivation given.

"Parts III. and IV. deal with the leaf-splitting blight and rind diseases; the first named is shown to be due to Mycosphaerella. The pineapple disease (Thielaviopsis ethaceticus) and the relation of certain insects and mites to it is detailed, and also the well known yet little understood Eleau disease. Various experiments in the preparation and disinfection of cane cuttings and in testing cane varieties for their resistance to disease that have been carried out are recorded, and should prove most helpful to growers.

"The ninth and concluding section deals with free-living nematodes inhabiting the soil about the roots of cane and their relation to root diseases. The root diseases are very serious and in these soil-inhabiting nematodes we have organisms capable, through their punctures, of giving entrance to smaller parasitic organisms that would hasten the death of the plant roots.

"The author describes no less than eighteen new species of these worms, and records five more found around the roots of diseased canes in Hawaii. They are included in the genera Dorylaimus, Tylenchus, Mononchus, Prismatolaimus, Cephalobus, etc., and one new genus, Anthonema, is described.

"The whole work is excellent in every respect, not only from an economic point of view, but as an example of the thorough way in which such scientific investigations should be carried out."

FERTILIZER HAND BOOK AND DIRECTORY.—The American Fertilizer Hand Book for 1908, just published by Ware Bros. Company, Philadelphia, Pa., is a book of 244 pages, a section of which is devoted to general information relating to the sources of the different fertilizer materials, and other matter of interest and practical value to those associated with the trade. The book contains three separate directories, viz.: Fertilizer Manufacturers' Directory, Allied Fertilizer Trades Directory and Cotton-seed Oil Mill Directory. The Fertilizer Manufacturers' Directory, also the Cotton-seed Oil Mill Directory, are arranged by States. Names of officers and capacity of plants are given. The Allied Fertilizer Trades Directory contains the names of houses that are associated with the fertilizer trade, properly classified for quick reference, and will be found very convenient for fertilizer manufacturers when in need of plant equipment, materials, or the services of an expert in any line. Ware Bros. Company, publishers, Philadelphia, Pa.; price, $3.00.

IMMIGRATION.

A recent issue of "The American Sugar Industry and Beet Sugar Gazette" contains what would appear to be an inspired article entitled "Hawaii and Contract Labor," relating to the bill which has been favorably reported by the House Committee on Immigration suspending for six years the prohibition against the importation of solicited European laborers into the Territory of Hawaii. The article contains so many false and misleading statements that it cannot pass unchallenged. It says:

"A bill has recently come before Congress which provides that the Hawaiian Government may be allowed to solicit immigrants in Europe, contract for their work and pay their passage, for a period of six years from the passage of the bill.

"There is no doubt that the Hawaii sugar industry would profit by the passage of this bill since it would prolong for a period of six years the *present conditions respecting cheap labor* on the islands. The principle of the bill does not, however, commend itself to the minds of Americans. In the interest of better citizenship, the contract labor law was enacted in this country. * * *

"Since the Japanese are beginning to learn their value on the mainland, numbers of them are immigrating (from Hawaii) to this country. It is to replace these losses and to prevent the Japanese who remain from demanding a higher wage that the planters seek to introduce contract labor from Europe. The history of such experiments in the past has been uniformly injurious to the countries making them—injurious in the worst sense that it strikes at the character of the citizenship and degrades free labor to the level of the contract class.

"It has been suggested that Hawaiians might better afford to pay a wage that would attract intelligent American workmen and so improve their citizenship from the ground up. There is just now a surplus of unskilled labor in the United States, and that labor could be attracted to Hawaii by a little push and advertising, provided the planters would pay the wage that American planters and beet sugar growers are forced to pay.

"Since Hawaii has the advantage of American markets free of duty, it should be willing to treat its working people with equal justice and fairness. Failing in this, we see no reason why the American Congress should relieve the Hawaiian planter from obedience to a law that his American competitor must observe.

"No truly republican government can exist in Hawaii until a policy of justice to the working classes has been adopted that will raise them to the level of similar classes in America, and Hawaii, under anything less than a republican government, is not a desirable possession for the United States."

In the first instance the preliminary statement that it is intended to import "contract laborers" as the term is used in the article is untrue. The purpose of the bill is to permit the Territory of Hawaii to continue European immigration exactly as it lawfully did previous to the amendments to the Immigration law in February, 1907. The proposed bill permits the Territory to solicit aliens to come to Hawaii by offers of employment, and to permit the Territory to pay the passages of such immigrants with money subscribed by individuals, companies, partnerships, or corporations. In no other essential respect is any change made in the existing immigration laws; no soliciting of immigrants, by private interests, is permitted, no contract of employment, express or implied, is permitted to be made with the alien induced to immigrate. No penal contract is permitted to be made with such immigrants after arrival, and such people are, in all respects, free agents, to work or not, to seek such employment as they may care to enter into.

Perhaps a sufficient answer to the charges that such immigration "strikes at the character of the citizenship and degrades free labor" and that "no truly republican form of government can exist in Hawaii until a policy of justice to the working classes has been adopted that will raise them to the level of similar classes in America" would be merely to remark that the proposed bill itself, and the object sought to be accomplished thereby, are distinctly and strongly approved by the President, who, after all the investigation he has caused to be made by his Cabinet and Bureau chiefs, will certainly be surprised to learn that he is favoring a measure that does not tend to build up Hawaii and its citizenship along American lines. We might note, also, that Secretary Strauss, Commissioners of Immigration and Labor Sargent and Neil, who have all visited here and studied conditions, have stamped their approval upon this measure.

If the person who wrote the article is correct, then Secretary Strauss was distinctly wrong when he penned the following:

"'These outlying possessions (Alaska, Panama, Porto Rico, Hawaii, Guam and the Philippines) not only differ from the body of the continental territory as to their position and needs with regard to labor, and immigration, but they differ likewise among themselves. It is not to be expected, therefore, that a particular policy of restriction in the matter of immigration, especially designed to meet the situation on the mainland, should be perfectly adapted to the needs of insular communities. Each of these communities has its own industrial problems to solve, and the conditions in each should be considered before it is brought within the operation of a general rule. The need of differentiation in the regulation of immigration I believe to be obvious for the reasons stated. The need was brought home to me with great force when, during the past summer, besides actually viewing the administration of the immigration laws along the borders of Canada and on the Pacific Coast, I personally visited the Hawaiian Islands and saw for myself something of the effect of these laws upon the occupations of the people. As a result of this experience and of the best consideration I have been able to give to the subject, I believe that the attention of Congress should be directed to the question of immigration into the insular possessions of the United States, to the end that the special conditions perculiar to these several possessions individually may be taken into account and expressly provided for by legislation."

The European immigration movement conducted by the Board of Immigration of the Territory, and which will be resumed if the proposed bill becomes a law, has cost the people of this country approximately a quarter of a million dollars. Those immigrants of the three shipments already brought in, who went to the sugar plantations,—and fully twenty per cent. of them have sought other employment,—have formed a nucleus of a citizen-labor population for these islands, are on a par with the best of the foreign element of any part of the mainland, and in all respects far superior, we venture to say, to seventy-five per cent. of the alien population that has been induced to take up its abode within the district covered by our Chicago contemporary. They are people who are seeking citizenship privileges, and when obtained will be able to enjoy such privileges with discretion and judgment.

If our friend is correct in his statements what could Senator Piles and Congressman Littlefield (both having visited Hawaii last summer) have meant when they made the following statements in public:

"I visited the Hawaiian Islands in company with a Congressional party last summer, and the people of the islands were gratified to see us because they felt that, by our visit in a body, the continental country was at last becoming personally interested in their welfare. The people out there are striving to make known their wonderful resources, and to invite an immigration which will aid in developing the islands along agricultural and other lines that may be profitably pursued by small investors."

"It ought to be said for the men engaged in the sugar industry, the corporations, that they have, in my judgment, exercised a liberal, progressive and patriotic attitude in connection with the question of the introduction of the right kind of labor and its proper utilization in Hawaii."

The statement that the sugar planters of Hawaii do not treat their labor with the justice and fairness received by such labor on the mainland is wholly false. Remember, in the first place, that a laborer and the working members of his family,—male and female,—can obtain employment in Hawaii during every day of the year; that he is furnished free of charge a house, water, fuel, and medical attendance; and, referring particularly to the European immigrant, that his personal taxes of five dollars per year for three years are borne by the plantation employing him; that the average wage for unskilled field hands, on a day-wage basis, is $23 per month; that if he desires to make his home on the plantation employing him, for three years, he may, at the end of that period, acquire in fee simple, without cost to him, an acre of land at an average valuation of say one hundred dollars, and a house thereon costing not less than four hundred dollars; that during the time such laborer lives in this country he must send his children to the puplic schools, which are conceded to be equal to the public schools of any other part of the United States; that his expenses for clothing and food are light when compared with such expenses on the mainland.

Compare these conditions with those existing on the mainland for unskilled field hands, with no settled homes, working steadily but six months of the year, and we doubt if any unprejudiced observer would say that employment on the mainland even at a higher rate of wage is preferable to employment in Hawaii.

In conclusion, one further thought: The beet and cane sugar industries of the mainland, and the cane sugar industry of Hawaii, have much in common, and coöperation in many matters would be mutually beneficial; but such coöperation will never be brought about, and no mutual understanding will ever be arrived at, so long as there is a failure on the part of such mainland industries to recognize that Hawaii is an integral part of the United States dominated by American ideals,—a small part, perhaps, but, nevertheless, a very vital part,—and that we will continue to be such whether the beet and cane interests of the mainland would have it so or not.

WEST INDIAN AGRICULTURAL CONFERENCE, 1908.

The seventh West Indian Agricultural Conference was opened at Barbados on January 14, 1908.

The sugar industry received first attention. Discussing the question of exports, Sir Daniel Morris pointed out that the chief concern at the present moment was in finding a reliable market for West Indian cane products. He referred to the favorable market for sugar and molasses offered by Canada, which imported direct from the West Indian colonies 79 per cent. of the total sugar consumed in the Dominion during the year ended June 30 last.

The increasingly valuable results that have followed upon experiments in raising seedling canes were dwelt upon. These canes not only yield a larger percentage of sugar, but are also more disease resisting. It is satisfactory to note that planters are recognizing the value of the best of these canes, and that year by year a larger area is planted with them. This is especially noticeable in British Guiana, where over 30,000 acres are now planted with seedling canes. Reference was made to the fact that on one estate in Demerara with 4,404 acres under seedling canes, and 1,570 acres under Bourbon canes, the seedling canes taken together averaged 26 per cent. better than the Bourbon for the crop of 1907. Amongst the seedling varieties, 2,403 acres were under B. 208, and this variety during the crop of 1907 yielded 40 per cent. more sugar than the Bourbon cane.

In a paper read by Mr. Bovell at the Jamaica Conference, 1907, it was stated that more profit was derived from the cultivation of the Barbados seedling canes on the above estate during the years 1903-6 than would cover the cost of the sugarcane experiments at Barbados since they were inaugurated in 1884.

Referring to the situation in regard to seedling canes in the Leeward Islands, Dr. Watts makes the following noteworthy statement: "If we take the exports of sugar from Antigua and St. Kitt's at approximately 25,000 tons, worth £200,000, and assume that the industry has benefited to the extent of only 10 per cent. by the introduction of disease-resisting seedlings, this would give the very rough approximation of £20,000 a year as a value of the introduction of new varieties of canes, a sum in excess of that spent in maintaining the Imperial Department of Agriculture in its entirety."

THE ENGINEER—HIS PROFESSION, HIS WORK AND HIS EDUCATION.

By A. Gartley.

Read before the Social Science Association of Honolulu.

HIS PROFESSION.

"I hold every man a debtor to his profession, from the which as men of course do seek to receive countenance and profit so ought they of duty to endeavor themselves by way of amends to be a help and ornament thereof."

These are the duties of the professional man summarized by Francis Bacon in preface to his "Maxims of the Law."

I will use this occasion to bring before you the claims to recognition of a new profession, that of engineering. It is not as old as the ministry, law or medicine—in fact, is a mere infant as compared with these, but it is a profession which many savants have pronounced the only one which does not live by the contentions, miseries or distresses of humanity.

Progress and development have been so rapid in recent years neither the public at large nor the engineer have had time to pause and consider the very important relation which the engineer bears to this development, or to a consideration of the very high order of specialized training which he requires.

In the early days the term engineer was applied to men engaged in fortifying cities and constructing engines of war. The real founding of the profession may be ascribed to Thomas Tredgold, who founded the Institution of Civil Engineers and defined in a broad way the profession of engineering as being "the art of directing the great sources of power in nature for the use and convenience of man," indeed a field of work of high order, of wide scope, and one requiring complete technical training and great intellectual attainment.

When the duties of any vocation demand the continuous exercise of scholarly attainments that vocation should be included in the list of professions, and those who perform its duties acceptably and adhere to a correct ethical code should be considered professional men. The engineer has raised his vocation to the rank of the professions.

The relations between the clergyman, the physician, the lawyer and his parishoners, patients, or clients are regarded by law and usage as sacred and inviolable. Engineers and others who are engaged in handling the forces of nature and interpreting its laws for the benefit and convenience of man are equally great factors in the power for good or evil. In no other profession are equally tangible results produced, but their ethical position is not understood or considered, and it is this materialistic side of the profession which has led many people to consider engineers as artisans rather than of the professions. In fact, they have been and are now laboring under two distinct embarrassments, external and internal.

First, externally, there is the universal confusion on the part of the public between the mechanic, the superintendent and the engineer. At a very recent meeting of the Society of Mechanical Engineers, where engineers of national and inter-national reputation were present, a man, high in another profession, advised the members of the society not to join in a machinists' strike, and the average capitalist often considers his own engineering knowledge and attainments equal or superior to those of the engineer.

The second, or internal embarrassment, is that arising from a lack of unity in the engineering profession and the non-adoption and non-adherence to a uniform, strict and correct ethical code.

In dealing with material matters, with inventions or the use of inventions, and in his relation to contractors the temptations are many, ranging from adverse interests to strong drink, and it is to be regretted that many engineers have not lived up to a standard which in other professions has been crystalized and established through generations or centuries of usage. Some engaged in engineering have had too low an idea of professional accomplishments, and many have failed to give due weight to both theory and practice. If the engineer would obtain the recognition due him these conditions must not exist.

In the early days of every craft or profession there exists between the individuals a feeling of jealousy or rivalry. When the profession becomes older this gives way to toleration, then to meeting for protection and common interest and so to mutual respect, professional brotherhood and a careful regard for the rights and privileges of others. This results in the establishment of a code of ethics.

It may be said that other professions are great in spite of codes and not because of them, but in a profession that is making the rapid strides that the engineering profession is now making it would seem that better relationship might be established and better work done by the actual drafting of a code, which, while it would act as no restraint upon and would be no guide to the unprincipled, would do much towards raising the engineer in the estimation of the public, his co-workers and himself.

The engineering profession has but recently been crystalized from the trades and crafts, and time, of course, has been required to develop the necessity of a code, and time and experience will be necessary to determine the conditions which shall govern. An engineer's relations to his employer or client, employees, brother engineers and the work in hand are so complex that an ethical code to meet his requirements must be drawn on extremely broad lines. Such a code assumes that men working under its broad precepts must have an equal breadth of view and that each one shall have formed for himself a practicable and correct theory of life.

Such a code has already been mentally formulated by many engineering workers and the right conception of life which they have daily manifested has improved the position of the engineer in his relation to the public, his client and his fellow-employee.

That recognition is coming may be seen from an editorial in a recent issue of the Wall Street Journal, in part as follows:

"The tablet upon the bridge itself contains the names of all of the municipal officials who held office during the constructiin of the bridge, but it gives inadequate recognition to Roebling, to whose genius alone the construction of the bridge is due.

"The engineer does the most important work in every great constructive undertaking. Next to him in importance comes the financier who has the courage and foresight to supply the capital which, joined with the skill of the engineer, makes the success of the enterprise possible.

"This is an age of engineering. Never has there been a time when the engineer was so important to the world's progress as today. This is because this is an era of construction.

"Man works not for money alone but for recognition. We have no orders nor decorations nor titles in this country. By all means let us adopt every method possible to do honor to the men who do the great constructive work of the times."

That this publication, devoted exclusively to financial interests, considers that the engineer occupies a position more important than the financier's in his relation to constructive enterprises and that his importance in the world's progress has never been so great as today, is good evidence that the engineering profession is beginning to receive the honor and respect denied it in former years.

HIS WORK.

Engineering is a reasonably exact science, but in every engineering problem the methods and results are subject to fixed and definite limitations. Surrounding conditions, strength and other physical properties of material and the known forces and powers available are some of the limitations. The discovery of a new force, a new property of matter, a new element, or a new method of operation acts on engineering problems like the changing of the constants in a mathematical equation. The paths which were definite and fixed become changed and modified. In recent years the application of electricity has resulted in a most radical change of constants in almost all branches of engineering, but in spite of these changes its broad application has brought harmony in the engineering ranks. It has laid the foundation for industrial and commercial coöperative operation on a large scale and may be counted as one of the strongest coöperative influences.

Coöperation is largely a result of the engineer's work and must entitled him to the highest recognition. The efficiency of great enterprises, the effectiveness of concentration makes coöperation one of the greatest discoveries of the 19th century, and the engineer in his close relation to every department of modern life as a real factor in conceiving, adjusting and operating the intricate mechanism of civilization, must be accorded a position in the advance guard of the discoverers.

When the individual worked at his bench or his loom and the total knowledge of science was limited, the constants in the equation of life were few and progress and development came by slow and careful steps. Individual jealousy and rivalry and the difficulty of communication, limited as to time and space, prevented advancement. The inventive and constructive imagination of the engineer and his discovery and application of new forces brought into use a deluge of machines, made travel and transportation cheap and easy and communication instantaneous. The resulting interchange of commodities, of ideas and of men, has given a wider field of action in industries, state, nation and the world at large. The individual has given way to coöperative enterprises and the triumphs and achievements of our modern life are a result of concerted action.

There needs to be no enumeration of the concrete evidences of the engineers' work or the vast enterprises upon which they have been and are now engaged. The Panama canal is perhaps the greatest single engineering undertaking in progress in the world today, and the benefits resulting from the successful accomplishment of this work will be so varied and vast that it would be folly to attempt to enumerate them. In a statement made recently by a technical paper it was shown that in the vicinity of New York city alone there are important enterprises under way depending upon the engineers for their successful completion, exceeding in cost more than five times the estimated cost of the Panama Canal. The increase of the water supply of New York, known as the Ashoken Valley Extension, alone is estimated to cost 162 million dollars.

It cannot be denied that in conceiving, executing and bringing these enterprises to successful termination the engineer is doing much towards improving the conditions of man.

HIS EDUCATION.

As a result of modern conditions the engineer has been caught in a whirlpool of his own making. The field of modern scientific knowledge and its application has so broadened that it is beyond the grasp of one man and of necessity the engineer must become a specialist, a condition quite similar to that in the learned professions of law and medicine.

If he lives up to the definition of his profession to "direct the sources of power in nature to the use and convenience of man," and expects to be successful, he must be educated and trained to produce tangible concrete results, efficiently and effectively.

Nature's sources of power are vast and varied and to effectively control them requires vigor and knowledge applied with a definite purpose. Simplicity of method and a rigid avoidance of unnecessaries, sound judgment, breadth of view, integrity of character with ability to understand and control men as well as matter, and to direct human forces as well as physical forces, are essential. Acting only, without actual accomplishment in the face of obstacles, means failure. Do, and do effectively, must be the key note.

Thus the requirements of the engineer demand that he have a highly specialized training and education, and the progress which engineering is making requires that progressive educational methods be applied. The technical school is a growth of recent years, and in engineering education the ideals, the methods and facilities are all new. The engineer is a new factor in the world's work and the graduate of the technical school a new product. Progressive educational methods cannot be fixed and definite, but must keep pace with the progress of the professions.

One of the first requisites in any professional education is that there shall be instilled into the mind of the student the relation between knowledge and experience and this is especially true in the engineering profession, where the problems are not abstract but are concrete. Theory and formula form but a small part of the requisites necessary for success. The engineer must deal with forces and material. He must know the constants of the material used and study the ultimate uses to which the resulting products are applied. In designing apparatus he must know not only the theoretical principles, but he must know the limitations of the materials, methods of using these materials and the manufacturing facilities which will ensure cheap and rapid production. He must be familiar with the operating conditions under which the results of his design must be used, and establish the limitations under which operation may be continued without overload or undue strain.

He must also study the limitations of the craftsmen, artisans and laborers who build his design and of the men who ultimately operate it.

The man who is educated in pure science alone, who has not the experience or ability to put his knowledge of principles into efficient practice cannot claim to be an engineer.

The rational present day method would dictate that an engineering student should have a thorough scientific and technical training and after its completion a practical experience in the particular branch of engineering which he chooses to make his life work.

In the technical training it is necessary that theory and practice go hand in hand, but greater weight should be given to pure science and the liberal arts.

The student should also be taught the limiting commercial conditions of engineering, and the absence of such instruction in the different technical schools has resulted in the turning out of men claiming to be engineers who have so often been found inefficient and uneconomical in their practice that business men are inclined to discriminate in favor of so-called "practical" engineers and against the so-called "theoretical" engineers.

In nearly all engineering work, and especially in the operation of industrial works, it is necessary to meet intelligent competition requiring improved and economical methods of production. This can only be done by careful analysis of the results as to product and cost obtained by keeping accurate detail records of the work step by step. The engineer must be in a position to pass upon the commercial advisability of any enterprise in which he engages himself. He must make complete and accurate estimates of the cost of the work and the gains resulting from its operation. This cannot be left to an accountant. The managing engineer, therefore, while he need not be an expert bookkeeper, must have a knowledge of the principles of accounting, be able to criticise the accounting methods followed, and, if necessary, to establish new accounting methods in order that he may provide himself with the necessary data to keep intelligent track of the work he has in hand.

It is a common thing to hear hard headed business men who have had experience with engineers' estimates say that 50 to 100 per cent. should be added as a margin of safety to the original estimate, and the woeful lack of business ability on the part of engineers has been sufficient reason for this criticism.

Another line on which the student should be taught is that of commercial law, especially in the making of specifications and contracts. This knowledge would curtail much business for the lawyers and courts, if specifications, contracts and correspondence were first carefully considered and made to express the real intent.

The student should also be given a good working knowledge of his mother tongue. He should be able to express himself correctly, clearly, forcibly and explicitly. If he can acquire some measure of elegance, so much the better, but first he must be taught to express his thoughts without ambiguity.

This has a two-fold function. First, the student himself will find in his steady endeavor to express himself clearly that the subjects are not quite so clear in his own mind as he had supposed. Second, the relation of the engineer to his client and employees must at all times be very explicit and clearly defined. He accomplishes his results through the employment of other people and it is essential that he convey to them in exact terms all orders and directions in order that the work may be successfully carried out.

Summing up: The engineering student should be instructed:

First: Thoroughly in the fundamentals of mathematics and the sciences;

Second: Given a good, practical instruction in English;

Third: Given instruction in the commercial side of engineering and business methods, particularly as bearing on engineering practice;

Fourth: He should be shown an example of a correct and practicable working theory of life.

This last item may require some explanation. It is rarely that a young man formulates in early life a proper course of action which will render to himself the greatest personal satisfaction and the greatest usefulness to his profession. Such a theory can be conceived by older men and should be formulated and presented to the engineering student in as simple and instructive a manner as possible. Perhaps the ultimate theory of life which he himself may form may not agree with this one, but it will set him to thinking and to determining for himself what his own course should be. The underlying motives of correct theories of life cannot be very different, although they may be subject to some materialistic limitations.

The educator should always bear in mind that the education of a technical school is a means to an end and that it is his duty to equip the student to be self-supporting and self-respecting. He must be taught to produce with reasonable effort the greatest output.

Greater attention should be given to a knowledge of principles than to knowledge of facts, for the practice is constantly changing and the principles are not. If he is taught to use this knowledge and also trained to use his powers of logic and reason as well as to acquire these, he will soon gain in his outside experience a capacity to look at things from all points of view, especially from that of the other man.

The student must also realize that the theoretically trained man is not completely equipped to undertake important engineering work nor to produce efficient results. He must have much experience before he can bring many of the engineering problems he will encounter to a successful issue.

When he enters upon the second course of his training, namely, that of acquiring practical experience, he must form his conception of life and manifest it in his daily activities if he desires to be successful. He has much technical knowledge which will be useful to him, but his first duty is to acquire more, and keep in constant touch with all his previously acquired knowledge. He should make whatever original investigation he can in order to develop his capacity for thinking and increase his own self-confidence.

Inventing is a high form of engineering activity and by concentrating his mind upon one thing, working patiently and persistently, he will be sure to achieve something which will be useful and a source of much personal satisfaction.

In his contact with men he acquires his knowledge of human relations in general. He must observe his superiors critically and without malice, but with a desire of finding out the best way of conducting work when called to perform their duties. He must form a clear idea of the ideal superior and attempt to form his life to this ideal. In relation to his co-workers, he should analyze the influences which have established them in their various positions; the influence of their previous experience and education and the things which have made them efficient and happy, and those things which have been a detriment to their progress. He should also study to acquire a knowledge of their views of life. The knowledge obtained through the individual will not be broad enough, however, on general life questions and he should study history, philosophy and economics, with a view of finding out the underlying motives in human relations. If he has been diligent the knowledge acquired through his technical training and subsequent observation and experience will place him in the ranks of educated, trained engineers, with ample resources to meet any situation.

During the period when he is acquiring experience it will be necessary for him to carefully form his character, making himself honest in all things, have a fixed purpose and undertake any and all problems cheerfully and persistently and aim to accomplish an efficient and creditable piece of work rather than to accomplish a work for selfish ambition.

He should at all times be polite and considerate to others, for in no other way can he retain his dignity.

A duty well performed will bring to him much personal satisfaction and he will find in every instance it will elucidate some truth and increase his sum of knowledge.

If he has lived up to Bacon's summary of the duties of a professional man and has at all times endeavored to be a help and an ornament to his profession the other compensations of recognition and profit will come as a result.

In this attempt to define the position of the engineer and outline a proper course for his education, I feel that I can speak with some authority from experience I have had in engineering work, my association with engineers and my observation of the deep imprint they have made on every phase of modern life, and I believe I have not stated the case too strongly. I hope it will not be thought I have fallen into the frame of mind of the "Three Tailors of Tooley Street," who made and addressed a petition of grievance to the House of Commons, "We, the people of England," but I do believe that a friend of mine in the engineering profession uttered a truism when he said "the lawyer may defend life, the physician save life, but it is the engineer who makes life worth living."

A THEORY OF THE EXTRACTION OF JUICE BY MILLING.

By Noël Deerr.

It is intended in this Bulletin to follow out algebraically the processes in general use applied to the extraction of sugar from canes, and to obtain expressions representing what results when different methods of working are employed under ideal conditions, that is to say, when the water used in saturation processes works at its maximum efficiency. Results so obtained will be strictly comparative amongst themselves, although they will not represent the imperfect conditions holding in the actual factory work.

The process adopted to extract the sugar from the canes may be divided into two parts:

1. The crushing of the canes without the addition of water or other diluent; this I shall refer to as the "Dry crushing."

2. The extraction of the residual juice left after the dry crushing by the saturation of the dry crushed bagasse with water or diluted juice, and subsequent recrushing. This I shall refer to as the "Saturated crushing."

In the simple algebraic formulae developed here f denotes the fibre per unit weight of cane, m denotes the fibre per unit weight of bagasse, and w denotes the water added in the saturation of the bagasse per unit weight of cane.

Preliminary considerations: If f and m have the significance already attributed to them, then the weight of bagasse per unit weight of cane is $\frac{f}{m}$ and the weight of the juice expressed is $\frac{m-f}{m}$. The weight of juice in unit weight of cane is 1 -f, so that the juice extracted per unit weight of juice in the cane is $\frac{m-f}{m\ (1-f)}$.

The weight of juice remaining in the bagasse is $\frac{f\ (1-m)}{m}$, and the juice lost in the bagasse per unit weight of juice in the cane is $\frac{f\ (1-m)}{m\ (1-f)}$. Owing to the first expressed juice being richer than that left in the bagasse, the extraction per 100 sucrose in cane is higher than is indicated by the formula $\frac{m-f}{m\ (1-f)}$.

If the sugar value of the expressed juice is indicated by unity and the sugar value of the residual juice by a, then the sugar value of all the juice in the cane is represented by

$$\frac{m-f}{m} + \frac{af\ (1-m)}{m} = \frac{m+af-f-afm}{m}$$

and the extraction will be given by the formula

$$\frac{m-f}{m} + \frac{m+af-f-afm}{m} = \frac{m-f}{m+af-f-afm}$$

With canes containing 12% of fibre and thereabouts, and dry crushed to 45% of fibre or thereabouts, it will be found on trial that the residual juice in the bagasse contains a percentage of sugar about 85% of that contained in the expressed juice; if, then, for a .85 be substituted it will be found that the extraction of sucrose is from 2.5% to 3.0% higher than is indicated by the formula $\frac{m-f}{m\ (1-f)}$. The variation depends on the amount of fibre in the cane, and on the relation between expressed and residual juice.

As typical of the results obtained in a modern mill I take 45% of fibre in dry crushed bagasse as representative of good modern work. In table I, I have calculated out the extraction obtained, when canes containing 10% to 14% or fibre are dry crushed to 45% of fibre, allowing an increase in the extraction of 3% over and above that indicated by the formula $\frac{m-f}{m(1-f)}$, so as to allow for the decreased sugar value of the residual juice in the bagasse.

The effect of the added water.

To $\frac{f}{m}$ bagasse obtained in the dry crushing let w water be added per unit weight of cane; let this water mix completely with the residual juice in the bagasse, the weight of which per unit of cane is $\frac{f(1-m)}{m}$. The weight of the bagasse and water is then

$$\frac{f}{m} + w = \frac{f + wm}{m}$$

and the residual juice in this bagasse is as has already been shown $\frac{f(1-m)}{m}$ so that the weight of diluted juice is

$$\frac{f(1-m)}{m} + w = \frac{f + wm - fm}{m}$$

If this saturated bagasse be crushed until it again contains m fibre per unit weight of bagasse, evidently the weight of diluted juice obtained is w and the proportion obtained of that originally present is

$$w \div \frac{f + wm - fm}{m} = \frac{wm}{f + wm - fm}$$

If the content of fibre in the dry crushed bagasse be m, and in the saturated crushed bagasse m', the proportion of sugar obtained of that actually present may be found in this way. To $\frac{f}{m}$ bagasse let w water be added; as before the weight of bagasse now is $\frac{f + wm}{m}$, and it contains $\frac{fm}{f + wm}$ fibre. Let this bagasse be crushed to m' fibre, when the weight of the bagasse becomes $\frac{f}{m'}$ and the weight of the diluted juice obtained is $\frac{f + wm}{m} - \frac{f}{m'} = \frac{m'(f + wm) - fm}{mm'}$. The whole weight of diluted juice in the saturated bagasse is $\frac{f + wm - fm}{m}$, so that the proportion obtained is $\frac{m'(f + wm) - fm}{mm'} \div \frac{f + wm - fm}{m} = \frac{m'(f + wm) - fm}{m'(f + wm - fm)}$.

These expressions may be used as the basis of a theory of the extraction of sugar from canes and incidentally to form a system of control.

Single maceration.

By this term I mean a process where the canes after the preliminary dry crushing are saturated once with water and again crushed, as opposed to a process entailing the return of the diluted third mill juices. I mentioned above that I took 45% of fibre in dry crushed bagasse as typical of good modern work; in the crop of 1907 the average fibre in the final bagasse in 25 Hawaiian factories was 49.65%, and I shall take 50% of fibre in the final bagasse as representative of good modern work. In Table No. II, I have calculated out what proportion of the sugar in the cane is obtained by a single maceration, with complete admixture, for different amounts of added water, in all cases after the canes have been dry crushed to 45% of fibre and after allowance as already detailed has been made for the decreased sugar value of the residual juice in the bagasse. It follows as a result of the equation, and as can be seen from an inspection of the table, that as the quantity of water added increases, the sugar obtained per unit of water added rapidly decreases; for example, with canes containing 10% of fibre, the addition of 10% of water corresponds to an increase in the extraction of 6%, and if 30% of water be added the extraction due to the water is 8.4%, an increase of only 2.4% for an addition of 20% of water.

The proportion of sugar extracted due to the dry crushing, and due to saturation, varies in accordance with the fibre in the cane; as the fibre increases, more sugar is left in the dry crushed bagasse, and a greater proportion is obtained, due to the saturated crushing; the admixture of the added water is never complete, and hence with high fibre in cane it becomes of greater importance to carefully oversee the admixture of the added water, and to obtain as efficient a dry crushing as is possible.

Double maceration.

Instead of applying the water in one dose it may, in a twelve roller mill, be applied in two, a portion after the preliminary dry crushing, and a portion after the saturated bagasse has been crushed in the third mill. The calculation of the extraction with complete admixture and upon the same data as before can be made as follows:

In the case of a cane with 10% of fibre crushed in the preliminary dry crushing to 45% of fibre, and then after the addition of water 10% on the weight of the cane, crushed to 50% of fibre, the total extraction (see Table II) is 95.05%, leaving 4.95% in the bagasse. To this bagasse let water 10% on weight of cane be again added with complete admixture, and let the bagasse saturated for the second time be again crushed to 50% of fibre; then of the sugar remaining $\frac{wm}{f + wm - fm}$ part is obtained in the expressed diluted juice. Substituting for w .10, for m .50, and for f .10, this expression becomes .5. Hence of the 4.95 sugar in the already partially treated bagasse $.5 \times 4.95 = 2.475$ is obtained, making the total extraction under these conditions $95.05 + 2.47 = 97.52$, compared with the 96.61 obtained under equal conditions, except that the water was added in one dose. In Table III, I have calculated the possible extractions on the supposition that the canes are first crushed to a fibre content of 45% and then twice in succession to a fibre content of 50%; water 10%, 15%, etc., being applied behind the second and third mills. The results of the calculation showing the extraction due to the added water may be compared with those set out in Table II, which was calculated on the basis that all the water was added in one dose; generally there is indicated an increase in the extraction in favor of double maceration of the order of 1%, and this is, I take it, the benefit to be obtained from a twelve roller mill, as compared with a nine roller mill when the quantity of cane milled remains the same. In a scheme of this sort so complicated a question as the increase in the capacity of the plant due to the installation of an additional mill cannot be expressed on paper.

The return of diluted juices.

The highest possible efficiency of the added water occurs when the diluted juices from the last mill are used to saturate the bagasse coming from a preceding mill; a complete algebraical expression representing this system of working is not easy to obtain, and when it is obtained it is not elegant. A comparison of working with water only, and with return of diluted juices is best shown by means of a worked out example.

Let the milling plant be a twelve roller mill; the canes are subjected to a dry crushing in the first six rollers until the percentage of fibre is 45%; water 30% on weight of cane is then added behind the *third* mill, and the diluted juices coming from the fourth mill are used to saturate the bagasse coming from the dry crushing; in the third and fourth crushings the bagasse is taken as having 50% of fibre; the cane is assumed to have 12% of fibre, and the same allowance as heretofore is made for the decreased sugar value of the residual juice in the bagasse and complete admixture of the diluents is assumed.

Canes containing 12% of fibre when crushed to 45% of fibre will on the lines already established afford in the expressed juice 85.82% of the sugar originally present, leaving 14.18% in the dry crushed bagasse; to this 14.18 let 30 water per 100 cane be added, and let the saturated bagasse be crushed to 50% of fibre; then applying the formula $\frac{m' \ (f + wm) - fm}{m' \ (f + wm - fm)}$ an extraction of 10.36 per 100 sugar in cane is obtained in this saturated crushing. Let the diluted juice containing this 10.36 sugar be applied to the dry crushed bagasse; the first effect of returning this diluted juice is to reduce the extraction from 85.82% to 85.82—10.36=75.46%, leaving 24.54% in the bagasse. If this saturated bagasse be crushed to 50% of fibre, 73.1% of the sugar it contains is obtained; .731%×24.54=17.94, so that the extraction at this stage is 76.54 + 17.94 = 93.40, and 6.60% is left in the bagasse as it now leaves the third mill. To this crushed saturated bagasse let 30 water per 100 cane be added, and let it be again crushed to 50% of fibre; then of the sugar present 55.5% is obtained; .555 × 6.60 = 3.66, so that the extraction has now reached 93.40 + 3.66 = 97.06%. Now let the 3.66 sugar contained in diluted juice be applied to the dry crushed bagasse, so that the extraction is reduced to 85.82 — 3.66 = 82.16, there now being 17.84% in the bagasse; as before, 73.1% of this ,or 13.04, is extracted in the third mill, making the total extraction at this stage 82.16 + 13.04 = 95.20, and leaving 4.80% in the bagasse; again adding 30 water, 55.5% of this, or 2.66% is obtained in the fourth mill, so that the total extraction now is 95.20+2.66=97.86%.

Proceeding in this way, and calculating the successive extractions by a series of steps, it is noticed that each successive addition to the extraction becomes smaller and smaller, until no appreciable difference between any two consecutive extractions is found; in this case the limiting value is found to be practically 98.0%.

Under equal conditions, but with the water applied half after the second and half after the third mill, and no return of diluted juice, the extraction was found to be 97.44.

For the purpose of convenient comparison, I collect here comparative data calculated on the lines followed above:

If the extraction in a nine roller mill with single maceration is	96.18
Then the extraction in a twelve roller mill with the same quantity of water added in two portions is...........	97.44
And if all the water be added after the third mill, and the last mill juice be returned behind the second mill, then the extraction is	98.00

I have not included any calculation of divided addition of water, or of return of diluted juices in a nine roller mill, as generally the bagasse coming from the first mill is not sufficiently well crushed to absorb a diluent, so as to obtain any useful effect.

The effect of an inferior dry crushing.

Instead of taking 45% of fibre in the dry crushed bagasse, let the percentage of fibre be 40%. Then if the canes contain 12% of fibre, the extraction due to dry crushing is 81.93%, leaving 18.07% in the bagasse; let this bagasse after the addition of water be crushed to 50% of fibre; below I have calculated what will be the extraction with single maceration after the addition of water 10%, 20%, etc., on cane, and for the purpose of comparison add the figures already obtained when the dry crushed bagasse contains 45% of fibre.

	Water added per 100 cane.				
	10	20	30	40	50
40% of fibre in dry crushed bagasse	92.26	94.29	95.48	96.26	96.80
45% of fibre in dry crushed bagasse	93.10	95.09	96.19	96.89	97.37

The advantage in favor of the more effective dry crushing is in reality greater than is shown in the above calculation; complete admixture is in both cases assumed; in practice we do not obtain complete admixture, but the admixture will be the less imperfect the more the bagasse is disintegrated; that is to say, when the fibre content is higher.

SUGGESTED METHODS TOWARDS THE CONTROL OF THE MILLING PLANT.

1. *The density of the last mill juice.*

On the supposition that the density of the juice is constant throughout the cane (a supposition that is not very far from the truth) it is easy to obtain the density of the last mill juice when complete admixture is assumed. For example, let canes with 12% of fibre be crushed until they contain 45% of fibre; then the weight of juice remaining in the bagasse per unit weight of cane is $\frac{.12\ (1 - .45)}{.45} = .1467$; let this juice be of density 18 Brix, and let water 20% on cane be added with complete admixture. Then the density after mixture, i. e., the density of the last mill juice is $\frac{.1467 \times 18}{.1467 + .2} = 7.61$.

In Table IV, I have calculated for a single maceration process the density of the last mill juice for degrees Brix, in the normal juice from 15 to 22, and for added water per 100 cane from 10 to 50, the dry crushed bagasse containing 45% of fibre, and the cane containing 12% of fibre. As the mixture becomes less complete, less solids are extracted, and the density of the last mill juice will fall. This table and calculation is introduced as a means of overseeing the efficiency of the added water.

Comparison of last mill juice with the residual juice in bagasse.

A number of years ago it was the custom in Java mills to work out a "Coefficient of admixture of added water" on the following lines:

$$\text{Sugar \% in residual juice in bagasse} = \frac{\text{Sugar per cent. in bagasse}}{1 - \text{fibre per cent. in bagasse}} \times 100.$$

$$\text{Coefficient of admixture} = \frac{\text{Sugar \% in last mill juice}}{\text{Sugar \% in residual juice}}$$

This figure does not appear in the more recent reports, and for this reason I believe that it is no longer employed.

The figure as it stands is liable to misinterpretation; if a small quantity of water has been used a high coefficient must necessarily result, even if no admixture whatever has taken place; and as the residual juice always contains less sugar than that already expressed an accurate comparison on these lines is impossible.

The relation between added water % on canes and between dilution % on normal juice.

As the weight of the canes is greater than the weight of the normal juice, it might appear that the figure giving the added water % on canes would be less than that giving the dilution % on normal juice; a great part of the water added does not, however, enter into the mixed juice, but passes away with the bagasse, and with complete admixture the figure expressing the added water % on canes will always be considerably greater than that expressing the dilution % on normal juice. To obtain a comparative table of these figures I proceed as follows: The degree Brix is taken as being uniform throughout the cane; let the degree Brix be 18; let the canes contain 12% of fibre and be dry crushed to 45% of fibre, after which with complete admixture water 20% on cane is added, and the saturated bagasse crushed to 50% of fibre. In a dry crushing following on the equations already established there are obtained 73.33 parts of juice at 18 Brix per 100 cane; 14.67 parts of juice are left in the bagasse, which, when completely mixed with 20 parts of water give 34.67 parts of diluted juice at 7.61 Brix; on crushing this bagasse to 50% of fibre there are obtained 22.67 parts of diluted juice at 7.61 Brix; this, when mixed with 73.33 parts of normal juice at 18 Brix, will give 96 parts of mixed juice at 15.55 Brix, and the dilution % on normal juice is by the usual method of calculation 15.75%; the added water per cent. on cane at the same time being 20%. In Table V, I have calculated for single maceration and complete admixture the dilution %, on normal juice when water 10% to 50% is added to canes containing 12% of fibre and dry crushed to 45% of fibre, and after saturation to 50% of fibre.

Now if the admixture is incomplete water passes into the mixed juice without carrying in the sugar which it was the object of its application to obtain, and the dilution will be higher than calculated above. Such a system of comparison gives, then, an idea of the efficiency of the added water, and may be used in the control or technical oversight of a mill, and it is to this end that the calculation has been introduced.

A method for expressing the efficiency of the added water.

A control or oversight of the useful effect of the added water is afforded, as has been shown above, by comparisons of the figures expressing the added water % on canes with the dilution % on normal juice, and also by comparing the density of the last mill juice with the calculated figure when the admixture is complete. A more exact and definite comparison may be obtained by the use of the following methods:

In a plant employing a single maceration process, let the canes contain 12% fibre, and let them be dry crushed to 45% of fibre; then on the lines already established, the extraction due to the dry crushing is 85.82%. Let water 20% on cane be added to the dry crushed bagasse; then with complete admixture and crushing to 50% fibre, a further extraction of 9.20 is obtained; suppose the actually recorded extraction is 93.63%; then that due to the saturation is 93.63—85.82=7.81. What may be termed the efficiency of the added water is then $\frac{7.81}{9.20} = 8.49$; i. e., the added water has extracted 84.9% of the maximum amount of sugar possible. To apply this formula in actual practice demands a knowledge of the fibre in the dry crushed bagasse, a determination that is not usually made; perhaps in actual work it would be sufficient to determine the average extraction due to the dry crushing process (varied, of course, as the fibre in the cane varies) and to use the figure so determined in the calculation of the efficiency of the added water.

Actually the amount of sugar extracted in the mills in these Islands falls short of that which with complete admixture would be obtained with a single maceration process; I am of the opinion that the calculated figure for the extraction due to saturation in a single maceration process might be made the basis upon which the efficiency of the added water is expressed, independent of what system of maceration is employed.

The effect of varying quantities of fibre in the material treated.

The effect of an increase in the fibre content of the canes in decreasing the amount of juice obtained in the dry crushing has been given in a preceding paragraph; with a maceration process somewhat different results are obtained, and a more extended analysis is given.

Let there be taken as types canes containing 10% and 12% of fibre, and let these canes contain the same amount of sugar, and be similar in all respects except in so far as concerns the percentage of fibre; as in previous examples, let these canes be subjected to a dry crushing to 45% of fibre, followed by a crushing to 50% of fibre after the addition of water 20% on weight of cane; complete admixture is assumed, and the same allowance as previously made for the decreased sugar value of the residual juice in the bagasse. The canes with 10% of fibre will give an extraction of 89.01% in the dry crushing, and those with 12% of fibre will yield 85.82%. An extraction of 95% is to be obtained in both cases; the amount of water necessary to be added in saturation to the bagasse can be obtained by solving the equation $\frac{m' (f + wm) - fm}{m' (f + wm - fm)} = a$, where a is the proportion of sugar required to bring the extraction up to 95% expressed as a part of that left in the bagasse after the dry crushing, and m, m', f, and w have the significance already attached to them. In the case of the canes containing 10% of fibre the sugar left in the bagasse after the dry crushing is $100 - 89.01 = 10.99$; to bring the extraction up to 95% there must be a further extraction of $95 - 89.01 = 5.99$, so that $a = \frac{5.99}{10.99} = .545$. Substituting for m, m', and f their proper values, w is found to be 9.76; i. e., water 9.76% on cane must be used to saturate the dry crushed bagasse. A similar calculation for the canes with 12% of fibre gives the quantity of water in this case as 19.62% on weight of cane.

With the canes containing 10% of fibre and finally crushed so that the bagasse contains 50% of fibre, the weight of the bagasse is 20% of the canes $\left(\frac{f}{m} = \frac{10}{50} = .20\right)$; the weight of canes and water added is 109.76, so that the weight of mixed juice is $109.76 - 20 = 89.76$ per 100 cane. A similar calculation for the canes containing 12% of fibre gives the weight of mixed juice as 95.62, and the weight of bagasse as 24 per 100 cane. The amount of sugar in the mixed juices is in both cases the same; let the mixed juice from the canes with 10% of fibre be 16 Brix; then that from the canes with 12% of fibre will be $16 \times \frac{89.76}{95.62} = 15.0$. A comparison of the results to be obtained from the two types of canes stands as below:

Fibre	Weight of mixed juice per 100 cane	Brix of mixed juice	Weight of bagasse per 100 cane	Extraction
10	89.76	16	20	95
12	95.62	15	24	95

In so far as regards the fuel economy I calcualte as under. To concentrate 100 parts of juice at 16 Brix to 55 Brix entails an evaportion of 70.90% on the weight of the juice. $.907 \times 89.76 = 63.64$, and if this is treated at quadruple effect it is equivalent to the evaporation at single effect of 15.91 water per 100 cane. The whole concentration to massecuite at 95 Brix entails the evaporation of 83.16% of the weight of the mixed juice; $.8316 \times 89.76 = 74.64$, so that $74.64 - 63.64 = 11.00$ is done at single effect in the pans. The whole evaporation referred to single effect will in this case be represented by the figure $15.91 + 11.00 = 26.91$. A similar calculation for the canes containing 12% of fibre gives the total evaporation as represented by 28.13. A greater consumption of steam is then required for an equal weight of sugar when the fibre increases, but on the other hand there is a very much greater quantity of bagasse to afford fuel.

The calculation made immediately above supposes ideal conditions, such as are never reached in practice, and may lead to the idea that it is my contention that canes of a high fibre content are more suited for factory work, owing to increased amount of fuel obtained, than those with a lower fibre content. Instead of assuming that the water works at its maximum efficiency, let it only extract half the amount of sugar that it obtained according to the calculation above. The extractions in the two cases now appear:

$$10\% \text{ fibre}; \quad 89.01 + \frac{5.99}{2} = 92.00$$

$$12\% \text{ fibre}; \quad 85.82 + \frac{9.18}{2} = 90.41$$

and the result is very different to what was obtained when ideal conditions of working were assumed.

A point of very considerable importance, and upon which this scheme of calculation bears is the trash which in greater or lesser amount accompanies the cane to the mill; in the calculation above it was shown that 2% more fibre in the cane had the effect of practically doubling the amount of water required to bring the extraction up to 95%, and that with imperfect admixture the extraction obtained with the canes with high fibre was even with this quantity of water much lower than that obtained under equal conditions with canes of low fibre.

Solar evaporation.

A problem similar to the above, but leading to a different conclusion, arises in the system of artificially ripening canes by the withholding of the irrigation water for a period of about three months previous to harvest; the result of this practice is, I take for this occasion, merely an evaporation of a part of the water contained in the cane, but little sugar being formed, the solution of that already present being concentrated.

Before the withholding of the irrigation water let there be 100 tons of cane containing 10% of fibre, 14% of solids, and 76% of water; let a process of solar evaporation continue until sufficient water has been removed to raise the fibre to 12%, the absolute weight of all the materials other than the water remaining the same; then the weight of cane will be reduced to 83.33 tons and the percentage of solids will rise to 16.8%. Now let the canes as they exist before and after the ripening process be treated by a single maceration process so as to obtain an extraction of 95%, from calculations similar to those already detailed, the results of the processes will appear as under:

Weight of cane	Fibre % in cane	Weight of mixed juice	Weight of bagasse	Water added	Brix of mixed juice	Extraction
100	10	89.76	20	9.76	14.6	95
83.33	12	79.65	20	16.34	16.5	95

the practical advantage of doing a portion of the evaporation in the field being very pronounced. A further advantage, which is not wrought out in the calculation, is the less weight of cane that has to be cut and transported.

TABLE I.

Showing the extraction per 100 sucrose in cane, calculated from the formula:

Extraction $= 100 \times \frac{m - f}{m\ (1 - f)}$; results being increased 3% to allow for decreased sugar value of residual juices; bagasse containing 45% of fibre.

Fibre in Cane.	Extraction.
10.	89.01
10.5	88.23
11.	87.42
11.5	86.64
12.	85.82
12.5	85.00
13.	84.17
13.5	83.34
14.	82.50

TABLE II.

Showing the maximum extraction to be obtained with single maceration, with complete admixture of added water; dry crushed bagasse containing 45% fibre, and saturated crushed bagasse containing 50% fibre.

Extraction due to saturation in upper, and total extraction in lower, line.

Fibre per 100 cane	Water added per 100 cane.								
	10	15	20	25	30	35	40	45	50
10.	6.04	6.95	7.58	8.04	8.39	8.66	8.88	9.07	9.22
	95.05	95.96	96.59	97.05	97.40	97.67	97.89	98.08	98.23
10.5	6.36	7.33	8.00	8.50	8.88	9.18	9.41	9.61	9.80
	94.59	95.56	96.23	96.73	97.11	97.41	97.64	97.84	98.03
11.	6.68	7.71	8.44	8.98	9.39	9.72	9.99	10.21	10.40
	94.10	95.13	95.86	96.40	96.81	97.14	97.41	97.63	97.80
11.5	6.97	8.07	8.85	9.43	9.87	10.23	10.51	10.76	10.96
	93.61	94.71	95.49	96.07	96.51	96.87	97.15	97.40	97.60
12.	7.28	8.44	9.27	9.89	10.37	10.75	11.07	11.33	11.55
	93.10	94.26	95.09	95.71	96.19	96.57	96.89	97.15	97.37
12.5	7.58	8.81	9.68	10.34	10.86	11.27	11.61	11.89	12.13
	92.58	93.81	94.68	95.34	95.86	96.27	96.61	96.89	97.13
13.	7.87	9.17	10.09	10.80	11.35	11.70	12.15	12.45	12.71
	92.04	93.34	94.26	94.97	95.52	95.96	96.32	96.62	96.88
13.5	8.17	9.52	10.50	11.24	11.82	12.29	12.68	13.00	13.27
	91.51	92.86	93.84	94.58	95.16	95.63	96.02	96.34	96.61
14.	8.46	9.87	10.90	11.68	12.30	12.80	13.21	13.55	13.85
	90.96	92.37	93.40	94.18	94.80	95.30	95.71	96.05	96.35

TABLE III.

Showing the maximum extraction to be obtained with double maceration with complete admixture of added water; dry crushed bagasse containing 45% fibre and saturated crushed bagasse containing 50% fibre.

Extraction due to saturation in upper, and total extraction in lower, line.

Fibre per 100 cane	Water added per 100 cane. 20	30	40	50
10.	8.51	9.37	9.85	10.15
	97.52	98.38	98.86	99.16
10.5	9.00	9.94	10.47	10.80
	97.23	98.17	98.70	99.03
11.	9.49	10.52	11.11	11.48
	96.91	97.94	98.53	98.90
11.5	9.94	11.06	11.71	12.12
	96.58	97.70	98.35	98.76
12.	10.42	11.63	12.34	12.79
	96.24	97.45	98.16	98.61
12.5	10.88	12.19	12.95	13.45
	95.88	97.19	97.95	98.45
13.	11.33	12.74	13.57	14.11
	95.50	96.91	97.74	98.28
13.5	11.78	13.28	14.18	14.66
	95.12	96.62	97.52	98.00
14.	12.23	13.82	14.78	15.41
	94.73	96.32	97.28	97.91

TABLE IV.

Giving the density of last mill juice in a single maceration process with complete admixture; the dry crushed bagasse containing 45% of fibre, and cane containing 12% of fibre.

Degree Brix of Normal juice:	Water added per 100 cane.								
	10	15	20	25	30	35	40	45	50
15	8.92	7.42	6.35	5.54	4.92	4.43	4.02	3.69	3.40
16	9.51	7.91	6.77	5.92	5.25	4.72	4.29	3.93	3.63
17	10.11	8.41	7.19	6.28	5.58	5.02	4.56	4.18	3.86
18	10.70	8.90	7.61	6.66	5.91	5.32	4.83	4.43	4.08
19	11.30	9.39	8.04	7.03	6.24	5.61	5.10	4.67	4.31
20	11.89	9.89	8.46	7.40	6.57	5.91	5.37	4.92	4.54
21	12.49	10.38	8.88	7.76	6.90	6.20	5.63	5.16	4.76
22	13.08	10.88	9.31	8.13	7.22	6.49	5.90	5.41	4.99

TABLE V.

Giving, for a single maceration process, the density of mixed juice and dilution per cent. on normal juice for canes containing 12% fibre, dry crushed bagasse containing 45% fibre, and saturated crushed bagasse 50% fibre, and normal juice containing 18% of solids.

Added water % on cane.	Density mixed juice.	Dilution % on normal juice
10	16.92	6.38
15	16.23	10.90
20	15.55	15.75
25	14.89	20.88
30	14.27	26.14
35	13.69	31.49
40	13.15	36.88
45	12.65	42.29
50	12.18	47.78

EVAPORATOR SCALE.

By S. S. Peck.

(Continued from February Number).

EXPERIMENTS WITH JUICES.

With the object of learning the amount of phosphoric acid retained by a juice after clarification, determinations were made with a juice from Daniel Dupont cane having the following composition:

Brix	15.73
Sucrose	12.69
Purity	80.67
Glucose	.60
Glucose Ratio	4.73

Mineral contents:

Soluble Ash, grams per liter	4.932
Insoluble Ash, " " "	3.760
Total Ash, " " "	8.692
Lime, " " "	.263
Phosphoric Acid, " " "	1.168
Sulphuric Acid, " " "	1.278
Chlorine, " " "	.212
Acidity, terms of N/10 Acid	.256

Equal quantities of this juice were clarified with varying amounts of milk of lime, with the view of having an acid, neutral and alkaline determination. The amount of lime necessary for this purpose was calculated from the acidity, but as will be seen, an insufficient quantity was added to produce neutrality. Duplicates of the acid and neutral clarification were made with 5 grams of calcium carbonate added per liter of juice. In each case the cold juice was tempered with lime until the desired reaction was achieved, the lime carbonate added, brought to a boil, kept at boiling temperature for two minutes, allowed to settle, and filtered through filter paper. The reaction was determined with phenolphthalein. The results are tabulated with the original juice for comparison in tables XIV and XV.

TABLE XIV.

ANALYSES OF JUICES.

	Brix	Sucrose	Purity	Glucose	Glucose Ratio	Acidity
Original Juice	15.73	12.69	80.67	.60	4.73	.256
Acid Clarification	16.96	14.01	82.61	.68	4.85	.120
Acid Clarification and Lime Carbonate	16.89	14.01	82.95	.68	4.85	.112
Neutral Clarification	16.28	13.45	82.62	.64	4.76	.084
Neutral Clarification and Lime Carbonate	16.09	13.31	82.72	.64	4.81	.068
Alkaline Clarification	16.17	13.48	83.36	.62	4.60	...

TABLE XV.

COMPOSITION OF MINERAL MATTER OF JUICE FROM ACID CLARIFICATION.

	Lime only	Lime and Calcium Carbonate
	(Grams per Liter)	
Total Ash	7.807	7.521
Soluble Ash	5.233	5.081
Insoluble Ash	2.574	2.440
Lime	.274	.266
Sulphuric Acid	1.443	1.523
Phosphoric Acid	.593	.591

TABLE XVI.

COMPOSITION OF MINERAL MATTER OF JUICE FROM NEUTRAL CLARIFICATION.

	Lime only	Lime and Calcium Carbonate
	(Grams per Liter)	
Total Ash	7.474	7.984
Soluble Ash	4.970	6.159
Insoluble Ash	2.504	1.825
Lime	.249	.260
Sulphuric Acid	1.426	1.528
Phosphoric Acid	.436	.432

TABLE XVII.

COMPOSITION OF MINERAL MATTER OF JUICE FROM ALKALINE CLARIFICATION.

	(Grams per Liter)
Total Ash	7.008
Soluble Ash	5.743
Insoluble Ash	1.265
Lime	.217
Sulphuric Acid	1.385
Phosphoric Acid	.065

The clarified juices showed marked differences in the time necessary for complete subsidence, the alkaline settling slowly, the others more rapidly, and of these, the ones containing the lime carbonate being the quicker. As regards the amount of phosphoric acid removed, there was no gain due to the carbonate, the percentages of removal being:

Acid Clarification	49.23	per cent.
Acid Clarification and Calcium Carbonate....	49.40	" "
Neutral Clarification	62.67	" "
Neutral Clarification and Calcium Carbonate..	63.01	" "
Alkaline Clarification	94.43	" "

The lime content of the alkaline juice was a little less than in the others. This has been ascribed to the formation of basic lime salts when juice is limed to excess, whereby calcic salts are thrown out of solution.

For the purpose of obtaining a juice which was strictly neutral a second and more complete series of experiments was planned, in which attention was directed exclusively to the phosphoric acid. As has been pointed out by H. Pellet and Noel Deerr, phenolphthalein is not a reliable indicator as regards the alkalinity of cane juice, one which is neutral to this reagent showing a decided alkaline reaction to litmus. It was suggested to the writer by Mr. Deerr that the color of the juice itself is a valuable guide to its reaction. A fresh lot of juice from the same variety of cane was procured, having the following composition:

Brix	16.19
Sucrose	13.18
Purity	81.41
Acidity	.125

Glucose was not determined, since the purity of the juice alone would sufficiently indicate any considerable destruction of sucrose.

The reaction was obtained by preparing mixtures of 20 c. c. of the juice in 250 c. c. of water, and after adding varying quantities of tenth normal soda, observing the reaction with a very delicate litmus paper obtained from Mr. Bartel, chemist of the Wailuku Sugar Company, and also the color in a 100 c. c. Nessler jar, with the following results:

5	c. c.	N/10	Soda,	distinctly	alkaline	to	litmus,	color	dark	green
4	"	"	"	"	"	"	"	"	"	"
3.5	"	"	"	"	"	"	"	"	"	"
3.0	"	"	"	faintly	"	"	"	"	green	
2.5	"	"	"		neutral	"	"	"	light	"
2.0	"	"	"		acid	"	"	"	yellowish	"
1.0	"	"	"		"	"	"	"	"	"

Even the first, however, showed no color reaction with phenolphthalein. It was concluded that the 2.5 c. c. brought the juice to neutrality, and from this the acidity of 0.125 deduced. Separate portions of 500 c. c. of juice were clarified with varying amounts of powdered quicklime with and without 2 grams of calcium carbonate, boiling being conducted as before for two minutes and the juice filtered after settling, as follows:

0.25 grams of lime,—settled poorly, juice remained cloudy, filtered slowly, reaction acid.

0.35 grams of lime,—settled fairly, clarification fair, filtered slowly, reaction acid.

0.45 grams of lime,—settled quickly, clarification good, filtered rapidly, reaction acid.

0.5 grams of lime,—settled quickly, clarification good, filtered rapidly, reaction acid.

0.525 grams of lime,—settled quickly, clarification good, filtered rapidly, reaction neutral.

0.55 grams of lime,—settled quickly, clarification good, filtered rapidly, reaction alkaline, color darker than the preceding.

0.6 grams of lime,—settled fairly, clarification good, filtered rapidly, reaction distinctly alkaline, color very dark.

No color difference was observable between those with and without calcium carbonate, but the sedimentation was more rapid with the latter. The reaction was first determined with the delicate litmus paper, and in the subsequent determinations of acidity, the juice with 0.525 grams of lime was accepted as being neutral. The reaction of the others was then determined by the amount of tenth normal acid or alkali necessary to bring them to the same depth of color as this standard, observations being made in solutions of the same strength in Nessler jars.

TABLE XVIII.

ANALYSES OF JUICES.

Lime Grams	Calcium Carbonate Grams	Brix	Sucrose	Purity	Reaction N/10 Solution	
..	.	16.19	13.18	81.41	.125	Acid
.25	.	17.06	14.06	82.42	.075	"
.25	2	17.16	14.01	81.64	"	"
.35	.	16.50	13.58	82.30	.040	"
.35	2	16.65	13.74	82.52	"	"
.45	.	16.96	14.01	82.61	.0038	"
.45	2	16.54	13.66	82.59	"	"
.50	.	16.69	13.90	83.28	.0014	"
.50	2	16.69	13.88	83.16	"	"
.525	.	16.75	14.04	83.82	Neutral	
.525	2	16.75	13.80	82.39	"	
.55	.	16.69	14.01	83.94	.0025	Alkaline
.55	2	16.69	13.82	82.80	"	"
.60	.	16.53	13.86	83.85	.0056	"
.60	2	16.53	13.78	83.36	"	"

A varying but almost regular drop is to be observed in the purities where calcium carbonate was added. It is not believed that this is due to any destruction of sucrose, and calcium carbonate is so slightly soluble as not to be able to cause any noticeable change in this respect. It is hoped that opportunity will later on be presented for further study in this direction.

Analysis of mineral matter was confined entirely to the determination of phosphoric acid. Table XIX shows the amount of phosphoric acid contained in grams per liter, and the percentage removed in each case. All calculations are based on the brix of the original juice.

TABLE XIX.

Lime Grams	Calcium Carbonate Grams	Phosphoric Acid Grams per Liter	Phosphoric Acid Removed per Cent
..	.	1.2122	....
.25	.	.6672	44.96
.25	2	.6629	45.31
.35	.	.4282	64.67
.35	2	.4521	62.70
.45	.	.2229	81.61
.45	2	.1993	83.56
.50	.	.1286	89.39
.50	2	.1281	89.43
.525	.	.0888	92.67
.525	2	.0888	92.67
.55	.	.0670	94.47
.55	2	.0674	94.44
.60	.	.0531	95.62
.60	2	.0406	96.65

It is apparent that nothwithstanding the immense restraining action possessed by calcium carbonate on the solubility of calcium phosphate in water or sugar solution, with and without alkaline chlorides, in the briefer period in which it is necessarily in contact with the juice and its precipitate, its effect is practically nil. It is evident, however, that the phosphoric acid found in scales is not entirely due to the suspended matter, but also to that which is in actual solution, since the results given above are from juices which have passed through filter paper. That suspended matter does affect it, there is no doubt. Perhaps a better indicator of the presence of such material is offered by the nitrogen content of the scales, that in the last being generally less than in the first bodies. An analysis of a scale from the Deming superheater in Mill "J" shows this difference more clearly, the nitrogen in the scales from the effects ranging from 0.31 to 0.47 per cent.

ANALYSIS OF SCALE FROM DEMING.

Organic Matter	30.18	per cent.
Mineral Matter	69.82	"
Nitrogen	1.86	"
Carbonic Oxide	.10	"

MINERAL MATTER.

Silica	.24	"
Iron and Aluminum	1.01	"
Lime	44.96	"
Magnesia	6.90	"
Phosphoric Acid	46.26	"
Sulphuric Acid	.42	"

While the results as regards scale prevention are negative, calcium carbonate does have a beneficial effect as regards rate of sedimentation, and will also produce a better press cake, which can be more readily and completely washed. An attempt has been made to utilize this substance in the treatment of syrup in diffusion plants. In a process patented by Dabrowski and Kaczmarkiewiez, the diffusion syrup is treated with natural powdered carbonate of lime, also with milk of lime. The powdered carbonate of lime is obtained from lime stone, chalk or pure marl. To the syrup is added, with continual stirring, one per cent. or more of carbonate of lime and sufficient milk of lime to impart to the syrup an alkalinity of 0.07. The syrup is afterwards heated to 80° C., whereby the sediment formed is separated more easily. The removal of this sediment gives a freer boiling syrup. What this sediment is composed of is not stated. but in the light of our present knowledge it is reasonable to suppose that it is largely composed of phosphate of calcium, with perhaps some sulphate of calcium which had already separated out from the syrup, but had not been deposited as scale in the effects.

Carbonate of calcium is soluble only to a very small degree in water free from carbonic acid, and less so in solutions of sugar than in water, the degree of solubility lessening with the concentration. It has, as far as known, no deleterious action on sugar; if further researches should show a method of utilizing it whereby the amount of scale formed can be materially reduced, it will be of immense value in increasing the efficiency of the effects.

REMOVAL OF PHOSPHATE SCALE.

The removal of phosphate scale by solution in boiling acid presents no great difficulty. A previous treatment with soda is always advisable, in order to disintegrate the organic matter, whereby the time necessary to dissolve the scale afterwards with muriatic acid is lessened. A solution of ¼ to 1 per cent. can be used, and boiling for an hour will leave the tubes practically free of incrustations.

LIME USED IN CLARIFICATION.

Care should be taken that the lime contains but a small percentage of impurities, particularly magnesia and soluble silicates, so that a minimum amount of substances tending to form scale is introduced into the juice.

METHODS OF MANUFACTURE TENDING TO DIMINISH SCALE.

Sand Filters. The use of sand filters prevents in a large measure the formation of scale. The kind of sand used influences to a considerable degree the advantages obtained. At one of the mills using these appliances, an appreciable reduction of scale was noticed after substituting coral sand for quartz sand. It seems probable that during the passage of the juice through the filters, not only was the removal of the suspended matter accomplished as effectually with the coral sand as with that first employed, but that there was also a precipitation or fixation of some of the dissolved phosphates due to their interaction with calcium carbonate, of which the sand is composed. To determine the action of the coral sand on the phosphate contents of the juice, the following experiment was carried out: Four and a half litres of juice from the same cane as was used in the previous determinations were clarified with four grams of lime. The clarified juice settled well, was of a light green color, and showed a slight acidity to litmus. Coral beach sand was prepared by copious washing with distilled water until all soluble matter was removed, and placed in a percolator to a height of four and a half inches. The clarified juice was filtered through filter paper and the usual analyses made. A part was sent through the sand filter, the first runnings being discarded, until the filtered juice had about the same density as the unfiltered. The rate of percolation was so regulated that the juice was in contact with the sand for about two minutes. The juice had naturally cooled somewhat during the time necessary for filtration through paper, and at the time of emergence from the sand filter was almost at room temperature. The composition of the juices was as follows:

TABLE XX.

COMPOSITION OF JUICES BEFORE AND AFTER FILTRATRATION THROUGH CORAL SAND.

	Brix.	Sucrose.	Purity.
Raw Juice	16.59	13.63	82.16
Clarified Juice	17.16	14.28	83.22
Sand Filtered Juice...	16.63	13.85	83.28

The mineral composition figured to the brix of the raw juice is given in the following table:

TABLE XXI.

MINERAL MATTER OF JUICES BEFORE AND AFTER FILTRATION THROUGH CORAL SAND.

	Raw Juice.	Filtered Juice.	Sand Filtered Juice.
		(Grams per liter.)	
Total Ash............	9.240	7.612	7.439
Soluble "	5.524	6.284	6.008
Insoluble "	3.716	1.328	1.431
Lime	.307	.215	.241
Sulphuric Acid..........	1.364	1.287	1.226
Phosphoric "	1.212	.185	.0859
Silica	.470	.213	.204

The action of the sand in removing phosphoric acid is very marked, the juice from the sand filter containing less than one-half as much of this element as that not filtered through sand. Where 84.73 per cent. of phosphoric acid was removed by the action of lime alone, 92.91 per cent. was taken out by the action of the lime and sand filter combined. In addition to the superiority of coral over quartz sand in this respect, is also the question of cost, an abundance of coral sand being available to most of our mills.

Intermediate Settling Tanks. Where the juice settles slowly after clarification, much of the sediment which would otherwise be carried into the evaporators can be gotten rid of by use of intermediate settlers. A continuous settler in one of our mills is ingeniously contrived from the tanks or boxes formerly belonging to a Taylor bag filter. These are combined into one large tank and divided into compartments by partitions of wood about twelve inches high running across the bottom perpendicular to the direction of the flow of the juice. This enters at one end and is continually discharged at the other, gradually depositing its sediment as it passes over the successive partitions, until that leaving the apparatus is almost perfectly clear. While not producing as brilliant a juice as sand filters, a material reduction of suspended matter is effected at a very low cost of time and apparatus.

METHODS OF MANUFACTURE TENDING TO INCREASE SCALE.

1. It is self-evident that a juice which settles poorly will make scale; in the absence of sand filters or intermediate settlers, clarification must be improved to avoid this. A very obstinate juice can be made to settle by the well-known method of over-liming and the addition of clariphos or a similar phosphoric acid combination, the heavy precipitate of calcium phosphate settling rapidly and carrying down with it most of the suspended matter. Care must be taken that the juice is left neutral or slightly alkaline, otherwise the object aimed at will be missed.

2. Returning remelted low grade sugars into the evaporators without previous clarification, it is obvious, introduces many impurities into the effects which would be avided if the remelts had first been sent through the clarification process with the mill juice. The objection has been urged against this that an increased sucrose content in the press cake is produced, or a greater volume of water used in the washing thereof made necessary; but if the remelt is allowed to mix slowly and continuously with the mill juice, this need not be feared.

3. Mixing press juice with the clarified juice just before it enters the effects is very liable to produce an immense amount of scale, particularly in the first body. Usually the scums are given additional lime and boiled up, before they are pumped into the filter presses, so that the press juice is of a greater alkalinity than the juices from which they originated. Any juice, unless limed to a considerable alkalinity will give a further precipitation when more lime is added; so that upon the admixture of the over-limed press juice with the neutral or under-limed clarified juice, a fresh precipitate is formed. Without any opportunity for depositing, this precipitate enters directly into the first vessel, with disastrous results to it as regards scale. It would seem that in such cases all difficulty might be avoided by a more heavy

liming of the juice for clarification. With many juices, however, it has been found necessary, in order to produce good settling or good boiling qualities, to keep them neutral, or even slightly acid. It is much better to run the press juice, whether it has been used for remelting low grade sugars or not, into the mill juice for re-clarification, or rather for re-settling.

The writer desires to express his obligations to Mr. A. E. Jordan, who assisted in the analytical work, and to the following publications, from which he quoted freely:

"International Sugar Journal."

"Sugar and the Sugar Cane," Noel Deerr.

"Beet Sugar Manufacture," Claasen; Hall & Rolfe's translation.

"Beet Sugar Manufacturing and Refining," Ware.

"Journal of the American Chemical Society,"
and various bulletins of the Bureau of Soils, U. S. Department of Agriculture.

Sugar Plantations, Cane Growers and Sugar Mills.

ISLAND AND NAME.		MANAGER.	POSTOFFICE.
OAHU.			
Apokaa Sugar Co	*	G. F. Renton	Ewa
Ewa Plantation Co	*	G. F. Renton	Ewa
Waianae Co	***	Fred Meyer	Waianae
Waialua Agricultural Co	*	W. W. Goodale	Waialua
Kahuku Plantation Co	x*	Andrew Adams	Kahuku
Waimanalo Sugar Co	**	G. Chalmers	Waimanalo
Oahu Sugar Co	x	E. K. Bull	Waipahu
Honolulu Plantation Co	**	Geo. Ross	Aiea
Laie Plantation	x*	S. E. Wooley	Laie
MAUI.			
Olowalu Co	**	Geo. Gibb	Lahaina
Pioneer Mill Co	x	L. Barkhausen	Lahaina
Wailuku Sugar Co	**x	C. B. Wells	Wailuku
Hawaiian Commercial & Sugar Co.	x*	F. F. Baldwin	Puunene
Maui Agricultural Co	...	H. A. Baldwin	Paia
Kipahulu Sugar Co	x	A. Gross	Kipahulu
Kihei Plantation Co	x*	A. J. McLeod	Kihei
HAWAII.			
Paauhau Sugar Plantation Co	**	James Gibb	Hamakua
Hamakua Mill Co	*x	A. Lidgate	Paauilo
Kukaiau Plantation	x	A. Horner	Kukaiau
Kukaiau Mill Co	*x	E. Madden	Paauilo
Ookala Sugar Co	**x	W. G. Walker	Ookala
Laupahoehoe Sugar Co	*x	C. McLennan	Papaaloa
Hakalau Plantation	**	J. M. Ross	Hakalau
Honomu Sugar Co	**x	Wm. Pullar	Honomu
Pepeekeo Sugar Co	**x	Jas. Webster	Pepeekeo
Onomea Sugar Co	**x	J. T. Moir	Hilo
Hilo Sugar Co	**	J. A. Scott	Hilo
Hawaii Mill Co	x	W. H. Campbell	Hilo
Waiakea Mill Co	*x	C. C. Kennedy	Hilo
Hawaiian Agricultural Co	**x	Wm. G. Ogg	Pahala
Hutchinson Sugar Plantation Co	**	Carl Wolters	Naalehu
Union Mill Co	*x	H. H. Renton	Kohala
Kohala Sugar Co	*	Geo. C. Watt	Kohala
Pacific Sugar Mill	x**	A. Ahrens	Kukuihaele
Honokaa Sugar Co	x**	K. S. Gjerdrum	Honokaa
Olaa Sugar Co	xx	J. Watt	Olaa
Puna Sugar Co	...		Kapoho
Halawa Plantation	x*x	R. H. Atkins	Kohala
Hawi Mill & Plantation	††	John Hind	Kohala
Puako Plantation	††	Jno. C. Searle	S. Kohala
Niuli Sugar Mill and Plantation	*x	Robt. Hall	Kohala
Puakea Plantation	*x	H. R. Bryant	Kohala
KAUAI.			
Kilauea Sugar Plantation Co	**	F. Scott	Kilauea
Gay & Robinson	x*x	Gay & Robinson	Makaweli
Makee Sugar Co	...	G. H. Fairchild	Kealia
Grove Farm Plantation	x	Ed. Broadbent	Lihue
Lihue Plantation Co	x	F. Weber	Lihue
Koloa Sugar Co	x	L. Weinzheimer	Koloa
McBryde Sugar Co	*x	W. Stodart	Eleele
Hawaiian Sugar Co	x*	B. D. Baldwin	Makaweli
Waimea Sugar Mill Co	*	J. Fassoth	Waimea
Kekaha Sugar Co	x	H. P. Faye	Kekaha

KEY.	HONOLULU AGENTS	
*	Castle & Cooke	( )
**	W. G. Irwin & Co	(8)
***	J. M. Dowsett	(1)
x	H. Hackfeld & Co	(9)
*x	T. H. Davies & Co	(8)
**x	C. Brewer & Co	(6)
x*	Alexander & Baldwin	(6)
x**	F. A. Schaefer & Co	(2)
x*x	H. Waterhouse Trust Co	(2)
††	Hind, Rolph & Co	(2)
xx	Bishop & Co	(1)